Space Weather Technical Forecast

Issued on Friday, 30 September 2022 at 01:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2/Minor-Moderate geomagnetic storms expected to develop from late today (30th) or through tomorrow. Chance of G3/Strong from CME arrival tomorrow.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with only minor C-class flares, the largest was a C5.6 observed at 29/0530 UTC, which appears to have originated from around the northeast limb.
There are currently four numbered sunspots on the visible disc, all either stable or gradually decaying. AR3110 remains the largest on the visible disc, and moderately geomagnetically complex. The remaining groups are relatively small and magnetically simple.

Solar Wind / Geomagnetic Activity: Solar wind parameters where indicative of a continued high speed stream influence, with the solar wind initially slightly elevated between approximately 450-500 km/s as measured by DSCOVR at L1. Then during the morning the solar wind increased, becoming elevated by the middle of the day, with speeds generally 500-550 km/s, although ending the day closer to 500 km/s. The density was predominantly at average levels, but briefly reached above average levels through the middle part of the day. The total Interplanetary magnetic field strength, Bt, was weak, peaking at 7nT. The north-south component, Bz, was initially positive, then weakly fluctuated, reaching a maximum southward extent of -4nT at 29/0730 UTC. The phi angle was mostly negative (towards from the Sun) during the first half of the day, then changed to become generally positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0 to 2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, was at or near background levels. High energy electron flux (greater than 2 MeV) was at predominantly background levels, briefly peaking at moderate levels at 111 pfu at 29/2140 UTC. The associated 24-hour fluence remained below the Active (1e8 integrated pfu) threshold. Observed fluence at 30/0000UTC was 1.11e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be generally Low, with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: The CME from the filament eruption on 28/0400 UTC has the potential to move across Earth tomorrow (1st). Solar winds are expected to be steady at first today, around elevated levels, before the next coronal hole high speed stream (HSS) from CH27/+ today and another HSS arrives from CH28/+ later tomorrow. The HSS influence is expected to persist through days 3 and 4 (2nd and 3rd). Quiet (Kp 1-2) geomagnetic activity at first, with possible isolated Unsettled (Kp 3) intervals. Then geomagnetic activity is expected to increase later today to G1/Minor to G2/Moderate storm levels (Kp 5-6). Activity levels may

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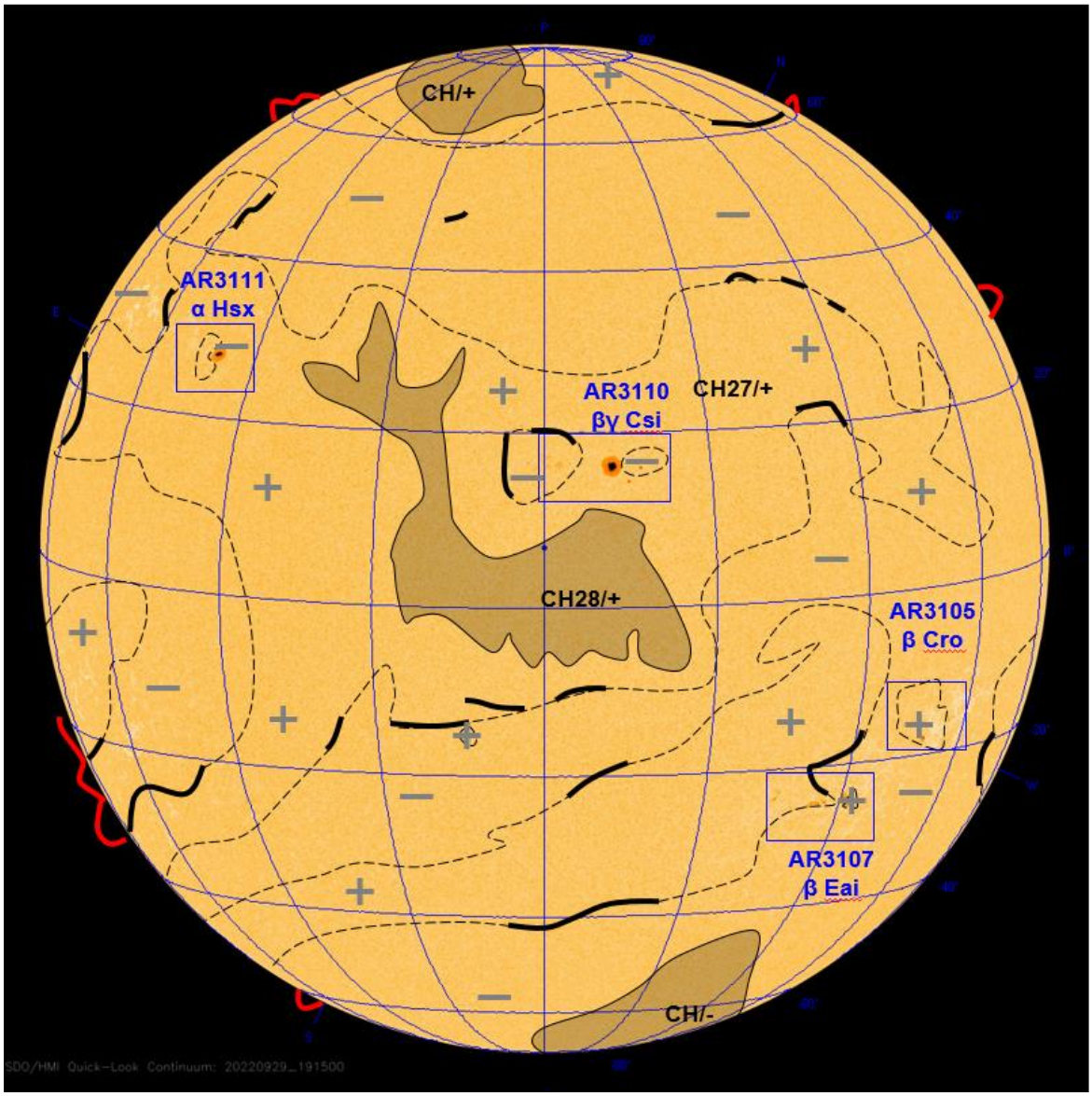
increase further tomorrow from any CME arrival, with a chance of isolated G3/Strong Storms (Kp 7) intervals. Activity easing to Quiet to Unsettled (Kp 2-3) by late day 4 (3rd).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at or close to background levels. The high energy (greater than 2MeV) electron flux will likely remain at mostly background initially, but likely rising to exceed High (1000 pfu) levels at times during days 3 and 4 (2nd and 3rd) . However, there is some uncertainty due to the potential CME arrival tomorrow (1st), with any associated geomagnetic activity possibly offsetting the influence of the two HSS. The associated 24 hour fluence is likely to rise in response, and may exceed the Active (1e8 integrated flux) threshold later day 4 (3rd).

Figure 1. Solar Analysis Valid 29/1915 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME from a filament eruption to the southwest of AR3110 around 28/0400 UTC has the potential to arrive at Earth tomorrow (1st). However this has a low confidence analysis due to the lack of STEREO A imagery, combined with low confidence in background winds in the current Enlil model.
Solar winds are currently steady at elevated levels, most likely residual influence from previous CH influence. The next HSS enhancements are expected to become geoeffective later today and through tomorrow, then persisting through the rest of the forecast period. These next enhancements are due to recurrent CH27/+ and CH28/+ which brought an extended period of Minor to Moderate geomagnetic storming on the last rotation (Kp 5-6). Similar activity is considered likely on this occasion, especially as the autumn equinox has recently occurred. There is some uncertainty with Enlil currently suggesting a slower arrival of the HSS influence, with weaker winds tomorrow and day 3 (1st and 2nd. However, the 27-day persistence is currently preferred. This indicates solar winds will likely rise late tomorrow, peaking over 600km/s.
Quiet (Kp 1-2) geomagnetic activity at first, with possible isolated Unsettled (Kp 3) intervals. Then geomagnetic activity is expected to increase later today to G1/Minor to G2/Moderate storm levels (Kp 5-6). Activity levels may increase further tomorrow from any CME arrival, with a chance of isolated G3/Strong Storms (Kp 7) intervals. Activity easing to Quiet to Unsettled (Kp 2-3) by late day 4 (3rd)

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	80	70	30
Strong	G3	No	20	30	10	1
Severe	G4	No	1	5	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0856	Partial	Filament Eruption	NE quadrant	810km/s	01/1000 +/- 10 hours	Likely embedded in HSS. Low confidence.

Figure 2: Enlil model ensemble indicating the potential CME arrival tomorrow.

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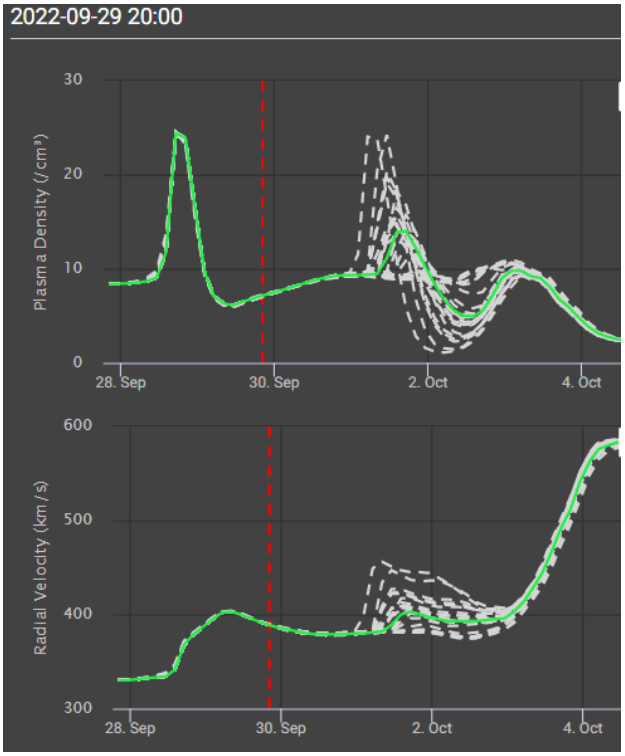

Radio Blackouts - X-Ray Flares:

Solar activity has been Low with frequent C-class flares, the largest of which was a C5.6 observed at 29/0530 UTC, which appears to have originated from around the northeast limb. There are currently four numbered sunspots on the visible disc: AR3105 has continued to gradually decline, and is now close to being downgraded to an Alpha classification. AR3107 has remained relatively stable over recent hours. AR3110 maintains a slow decay in its trailing spots, and is now classified as Csi/beta-gamma. AR3111 remains a small and simple uni-polar spot. Recent CME's observed from just over the limb, along with far-side products, such as helioseismology, and also STEREO A euvi imagery, all suggest a returning active region, ex-AR3098 are expected to rotate onto over the northeast limb during day.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	25	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 has declined from

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very slightly elevated levels to near background. While AR3105 and AR3107 move into an increasingly geoeffective location for proton events, there is only a very slightly above background level chance of these regions producing proton rich flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux, as observed by GOES-16 has been largely at background levels. The next significant rise in high energy electrons is anticipated to be once the fast winds from CH27/+ and CH28/+ become established, most likely through days 3 and 4. However, building electron counts will be complicated by the potential CME arrival tomorrow (1st Oct). Further geomagnetic enhancements from a CME arrival would help to supress high electron flux levels. and therefore peak values of over 10000 pfu may not occur until day 4 (3rd). The associated electron 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold until at least day 4 (3rd), while on a generally increasing trend. The REFM is currently over-estimating fluence values, which does not aid confidence in the fluence rising above the Active threshold by late day 3 (2nd). Instead a potential rise in the fluence to breach the Active threshold is preferred for day 4.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	20	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	2

Figure 3: Met Office REFM, with an increasing trend which is accepted, but the rise above the Active threshold is considered too fast.

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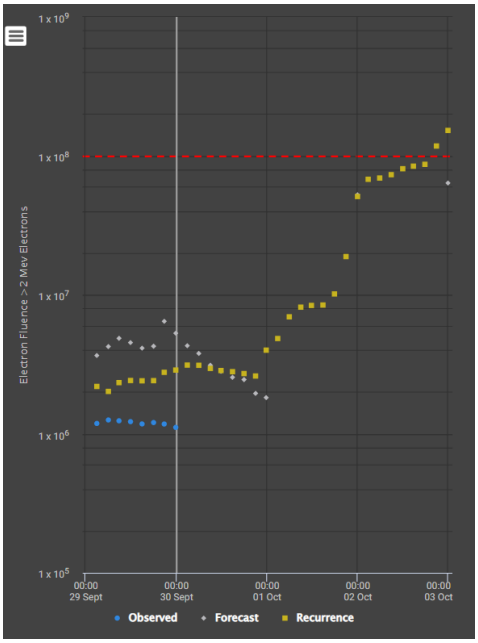

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